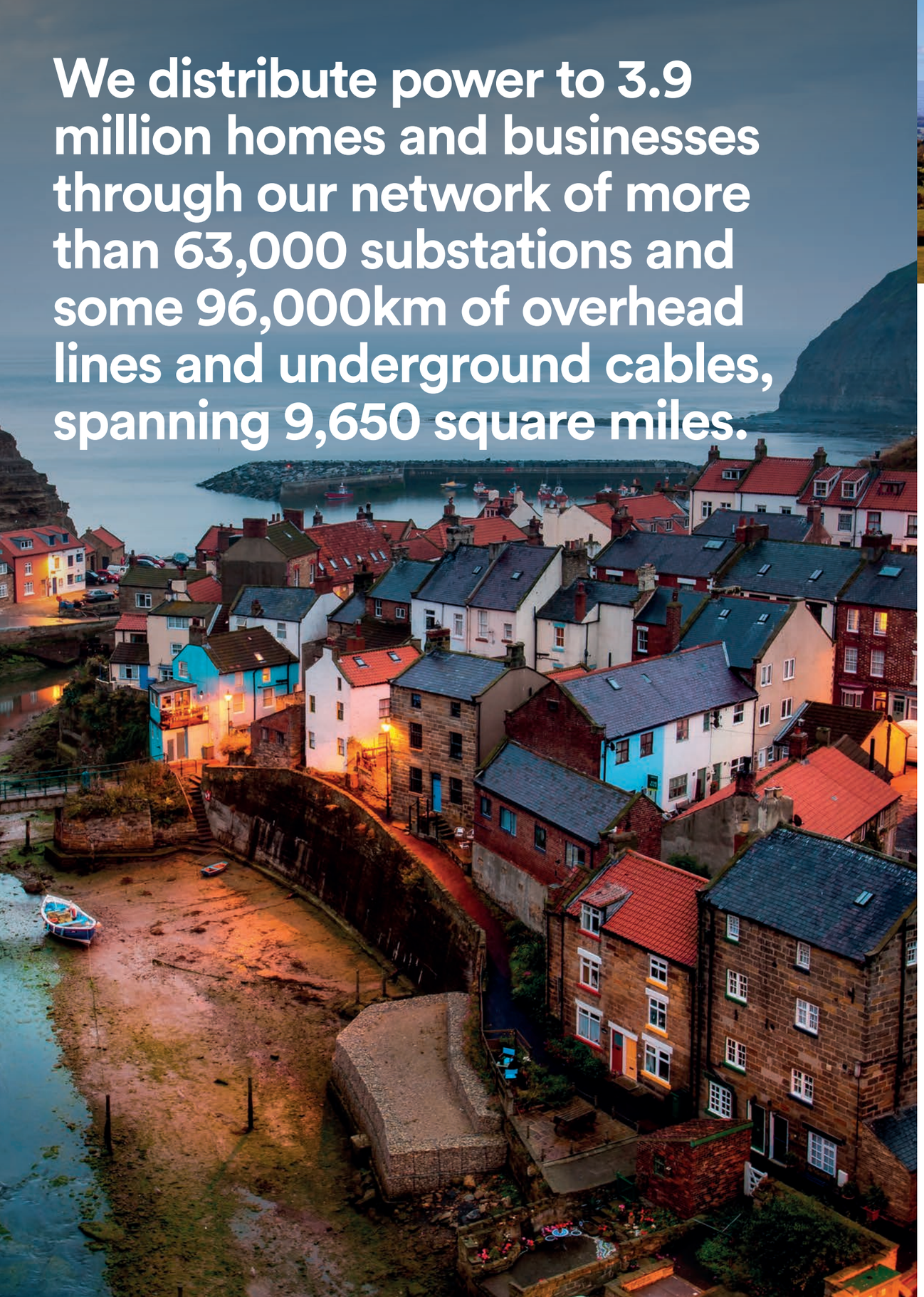

# Facilitating sustainability

Environment Report 2018

We distribute power to 3.9 million homes and businesses through our network of more than 63,000 substations and some 96,000km of overhead lines and underground cables, spanning 9,650 square miles.



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# 1. Introduction

**We continue to perform strongly against our environmental goals and we are confident that we are on track to deliver our business plan commitments and, in several cases, exceed those commitments.**

## 1.1 Executive summary

Our environmental performance continues to be strong, underpinned by a combination of investment, innovation, and diligent execution of our Environmental Management System. Our business carbon footprint continues to fall, outperforming the target we set ourselves. We now forecast that we will be able to deliver even more substantial progress on reducing the carbon emissions, $SF_6$ losses, and oil leakage by 2023 than we planned. Although we are slightly behind on our fluid-filled cable replacement programme at this stage, we have identified additional investment we want to make such that by 2023 we expect to have replaced over 50% more cable than our original ED1 commitment.

Our four innovation priorities of smart grids, smart meters, digital-enabled services, and issues of affordability continue to be highly relevant to our stakeholders, the country's transition to a low carbon economy, and our own transition to the role of Distribution System Operator (DSO). In 2017-18, we have almost tripled our investment in regulated innovation projects, reaching a £4.1m investment and adding 11 new projects to our innovation portfolio. We have made more progress in transition to the role of DSO. Our *Customer Led Distribution System* innovation project will inform the most appropriate market design and industry structure for the future energy system. In 2018, we have also started building our capacity to enable flexibility services and we started rolling out our smart grid enabling technology programme, where we expect to invest £83m by 2023.

We continue to support the national smart meter roll-out and our systems are ready to receive the data from the smart meters installed within our distribution licence areas. Thus, we are ready to deliver the benefits we committed to our customers.

## Key facts
### Environment and innovation in 2017-18

**£4.1m**
invested in 26 innovation projects in 2017-18.

**43.7km**
Total length of overheadlines put underground in National Parks and Areas of Outstanding Natural Beauty.

**34%**
reduction in business carbon footprint, achieved against our ED1 business plan baseline.

**379MW**
of renewable generation connected in 2017-18.

## 1.2 Our business

We are Northern Powergrid. We are responsible for the network that takes electricity from power stations and smaller generators to 3.9 million homes and businesses across the North East, Yorkshire and northern Lincolnshire. We are here 24 hours a day, seven days a week, 365 days a year to make sure that the electricity you need gets to you safely, whenever and wherever you need it.

If, for any reason, your power gets interrupted, it will be us who come to fix it and we will respond night or day.

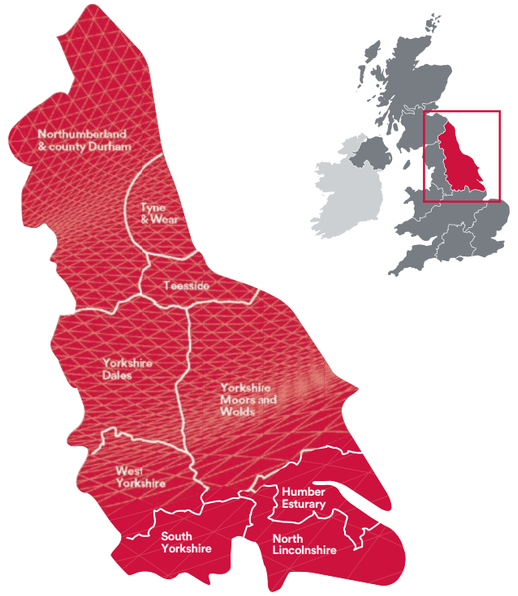
We have 2,700 employees looking after more than 63,000 substations and over 96,000km of overhead power lines and underground cables, spanning 9,650 square miles.

The amount of revenue that we recover from our customers is defined by Ofgem through a process that takes place every eight years and our performance is monitored on a yearly basis, from 1st April to 31st March. The current eight-year period is called RIIO-ED1 and lasts from 2015 to 2023[1].

We are committed to promoting environmental awareness, best practice and legal compliance among all our staff. We take our environmental responsibilities seriously and manage the environmental impact of our activities very closely. This includes our carbon footprint, the risk of noise, water and land pollution, waste recycling and caring for wildlife. We also manage the visual impact of our overhead lines, balancing the requirements of running our network with our stakeholders' expectations.

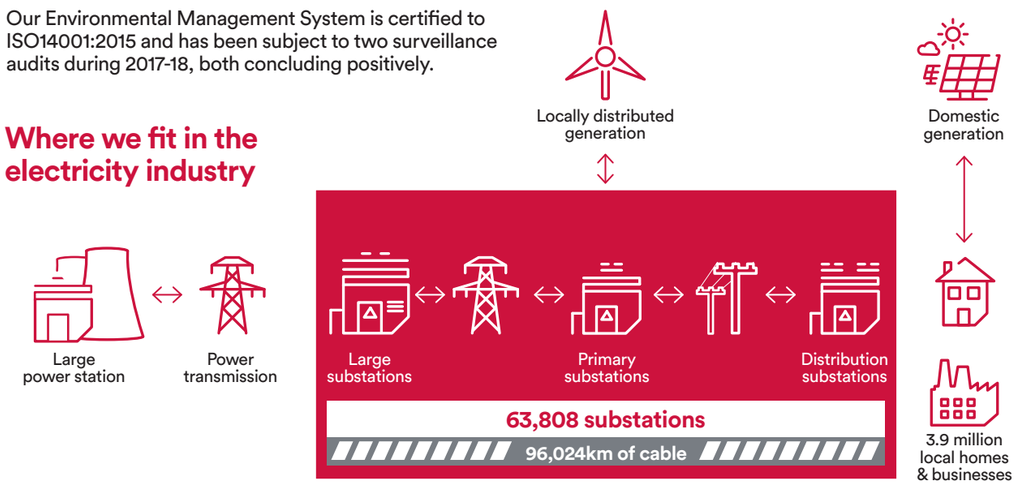
Our Environmental Management System is certified to ISO14001:2015 and has been subject to two surveillance audits during 2017-18, both concluding positively.

## Our nine operating zones




[1] For more information, refer to: ofgem.gov.uk/network-regulation-riio-model/riio-ed1-price-control

## Where we fit in the electricity industry



## 1.3 Purpose of the report

Environmental Respect is one of six core guiding principles for all Berkshire Hathaway Energy companies, including Northern Powergrid. We recognise the wider role and the impact our activity can have in the communities where our customers live and work because we live and work there too.

We believe our reputation and the trust held by our stakeholders, be they customers, special interest groups, the energy industry or partners, should be nurtured and this report shows how we turn words into deeds.

This report aims to provide stakeholders with an account of what we are doing to address environmental matters, including our role in the transition to a low carbon future. All year round, we listen to what stakeholders tell us they would like to see from us, and they are able to read here about the progress that we have made. We describe all of our innovation activity to provide stakeholders with a single source of information, even if it is not all directly related to the environment. Included as annexes to this report are the data and information that was submitted to our regulator as part of the annual regulatory reporting cycle. This information is available on our website and accessed using the links described below.

The information presented in this report meets the guidance issued by our regulator. Significantly, the structure of the report is consistent with those produced by other Distribution Network Operators (DNOs) to aid comparison and cross-referencing between companies. If you have any views or additional questions, get in touch at yourpowergrid@northernpowergrid.com.

### Environmental Respect

**We are committed to using natural resources wisely and protecting our environment for the benefit of future generations. Our Environmental RESPECT Policy details this commitment in the areas of Responsibility, Efficiency, Stewardship, Performance, Evaluation, Communication and Training.**

**Associated documents:**

— **Annexes 1 to 7 to the Environment Report 2017-18**, October 2018 – this is a copy of our submission to the regulator and consists of data tables.

— **Detailed commentary associated with the annexes to the Environment Report 2017-18, October 2018** – this is a copy of our submission to the regulator and consists of commentary associated with the data tables.

— **Cost benefit analyses** – these are numerous analyses that support net benefit calculations as submitted to our regulator.

All are available from northernpowergrid.com/your-powergrid/environment

— **The Stakeholder Annual Report, October 2018** – this report sets out the commitments we made and our progress against them, for the main areas of the business. It is available from: northernpowergrid.com/your-powergrid.

| Our performance measures | 2016-17 actual | 2017-18 actual | 2017-18 target | Status | 2018-19 target | ED1 target | Trend |
|---|---|---|---|---|---|---|---|
| Carbon footprint excl contractors (tonnes $CO_2$) | 23,286 | **21,273** | - | Achieved | - | - | ▼ |
| Carbon footprint inc contractors (tonnes $CO_2$) | 45,528[1] | **39,535** | **58,409**[7] | Achieved | 57,713 | 53,730 | ▼ |
| $SF_6$ lost to atmosphere (kg) | 114 | **98** | **112**[7] | Achieved | 100[2] | 100[2] | ▼ |
| Oil loss from all sources (litres) | 36,791 | **29,562** | **50,963**[7] | Achieved | 30,750[3] | 28,325[3] | ▼ |
| Cumulative km fluid-filled cables replaced to reduce oil loss | 39.9 | **68.1** | **73.6** | Missed | 125.4[4] | 205.7[4] | ▲ |
| Cumulative km overhead lines undergrounded in protected landscape | 29.9 | **43.7** | **36.6** | Achieved | 74.6[5] | 120.0[5] | ▲ |
| Street works inspection compliance (%) | 93% | **94%** | **>90%** | Achieved | >90% | >90% | ▲ |
| Number of Environment Agency reportable incidents each year | 10 | **8** | **27**[7] | Achieved | 26 | 22 | ▼ |
| Smart meter intervention performance (category A and B defects)[6] | 87% | **86%** | **90%** | Missed | 90% | 90% | ▲ |

[1] Our business carbon footprint for 2016-17 (including contractors) has been re-stated to address an error in the numbers submitted to Northern Powergrid by a contractor organisation.
[2] Stretch target – represents a further 10% reduction in $SF_6$ lost to atmosphere against our original ED1 business plan target (112kg in 2023).
[3] Stretch target – represents a 47% reduction of oil loss from all sources for the ED1 period. Our original ED1 business plan target was a 15% reduction (45,258 litres in 2023).
[4] Stretch target – represents an additional 54% (72km) in fluid-filled cable replacement. Our original ED1 business plan target was 133.6km.
[5] Stretch target – represents an additional 23% in our undergrounding of overhead lines in protected landscapes. Original ED1 business plan target was 97.9km.
[6] Our smart meter intervention target is based on achieving an agreed level of service on Ofgem's 2% assumption of defect rates for all smart meter installations. We have received over twice as many defect reports than forecast but only narrowly missed the target.
[7] Value has been updated.



# 2. Managing our environmental impact

## 2.1 Introduction

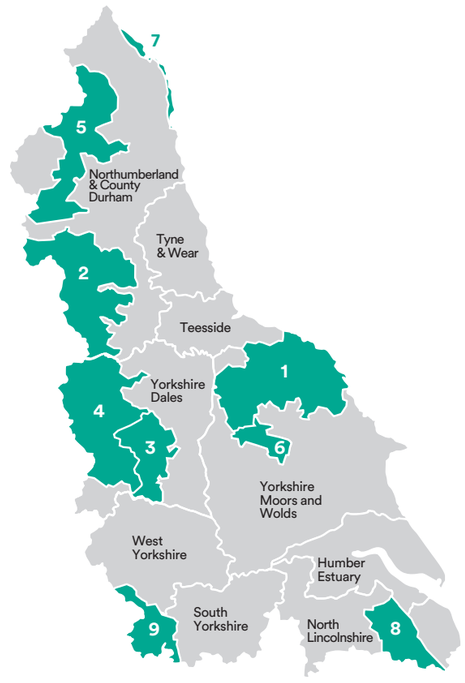
The impact on the environment of our activities is diverse. About a third of the total length of our cables and lines is overhead, and we work with our stakeholders to minimise the visual impact of these assets in National Parks (NPs) and Areas of Outstanding Natural Beauty (AONBs). Some of our cables are filled with oil, and we report here on what we're doing to reduce the risk of leakage.

We also explain how we manage our carbon footprint, particularly that coming from our use of the $SF_6$ gas, and losses from our network. Finally, we provide an overview of our climate change adaptation plans and of how we help train our employees on these matters.

## 2.2 Visual amenity: Moving overhead lines underground to reduce their visual and environmental impact

Overhead electricity lines can have an impact on the appearance of the landscape and affect local wildlife. It's our statutory duty to bear in mind the purpose of NPs and AONBs (collectively known as 'Designated Areas') and conserve the biodiversity within them. We have a special programme of work dedicated to removing overhead lines selected by stakeholders and replacing them with underground cables in these Designated Areas. Four NPs and five AONBs fall either partly or entirely in our two licence areas. The lengths of overhead line within each area as of 31 March 2018 are shown in Figure 1.

**Figure 1: Designated areas in our regions**




| | Designated area and stakeholder | Length of overhead line (km) – March 2018 |
|---|---|---|
| 1 | North Yorks Moors NP | 1,167 |
| 2 | North Pennines AONB | 716 |
| 3 | Nidderdale AONB | 584 |
| 4 | Yorkshire Dales NP | 592 |
| 5 | Northumberland NP | 342 |
| 6 | Howardian Hills AONB | 260 |
| 7 | Northumberland Coast AONB | 83 |
| 8 | Lincolnshire Wolds AONB | 441 |
| 9 | Peak District NP | 202 |
| | Total | 4,388 |

In 2017-18 we spent £600,000 in Yorkshire and £2,240,000 in the North East[2] and put 14km of overhead lines underground. Our total budget for the eight-year regulatory period which ends in 2023 is £14.7m and this budget is split between the Designated Areas according to how much overhead line falls within its footprint (see Figure 1). We're on target to meet our commitment to place 97.9km of overhead lines underground earlier than expected (by 2021) and expect to remove 20km more than we planned in ED1 at a cost of £2 million.

[2] For more information about costs and length of cables undergrounded, refer to Annex 1 (our annual submission to the regulator).

## Our stakeholder engagement and support

We work closely with stakeholders from each of the NPs and AONBs so that together we can have the most positive impact on the look of these beautiful areas. Our programme steering group, made up of representatives from our stakeholders and members of our design, wayleaves and delivery engineer teams, meet up twice a year to identify and prioritise projects and discuss any other issues including policy development and publicity.

We maintain day-to-day control over this work and provide regular feedback to stakeholders. We appreciate that many of our stakeholders are facing pressures on their resources so we support them as best we can and work efficiently as we deliver this important work together.

Based on feedback from our stakeholders, we created a webpage dedicated to our undergrounding work so interested parties can check the status of each project[3]. After sharing it with the stakeholder group, we've adapted it based on their feedback and we update the information it provides every month.

## Our strategy for project assessment and delivery, including analysis of costs and benefits

Our undergrounding programme is designed to meet the needs of representatives from the Designated Areas. We're aiming to make it easy for them to access the information and expertise they need to make an informed choice.

We invite representatives from the Designated Areas to state their preference for underground schemes, in line with the jointly agreed Assessment and Stakeholder Participation Policy. The stakeholders draw up a priority list of potential projects taking into account the characteristics of each site and the visual and environmental impact of the overhead line. This leads to each site being given a Stakeholder Rating which, alongside our own engineering wayleaves and value-for-money assessment, results in a project either progressing to authorisation or being deferred or cancelled. It's a thorough methodology which helps the stakeholders to make an informed decision. For simplicity, we only report the resulting score in Table 1, where you will find the status of projects proposed by stakeholders.

**120km**

We are committed to laying 120km of undergrounding by 2023.

**14km**

Length of overhead lines put underground in Designated Areas this year.

[3] The webpage is available on: www.northernpowergrid.com/your-powergrid/article/undergrounding



**Table 1: List of schemes progressed by stakeholders against the 2015-2023 budget**

| Designated Area | Location | Length of line for undergrounding (km) | Stage in the process | Stakeholder Rating* |
|---|---|---|---|---|
| Howardian Hills AONB | Crambe | 0.3 | 5 – Complete | 28 |
| | Cawton | 0.7 | 5 – Complete | 60 |
| | Nunnington West | 0.7 | 5 – Complete | 45 |
| | Ganthorpe | 0.5 | 5 – Complete | 39 |
| | Low Easthorpe | 0.6 | 3 – Confirmed by stakeholder & ready to deliver | 98 |
| | Grimstone Top | 1.2 | 2 – Proposed and awaiting land consents | 60 |
| | York – Oswaldkirk 1 | 1.4 | 2 – Proposed and awaiting land consents | 45 |
| | Castle Howard Guest | 0.6 | 1 – Proposed for design and feasibility | 60 |
| | Yearsley | 0.9 | 1 – Proposed for design and feasibility | 24 |
| | Low Hutton | 0.4 | 1 – Proposed for design and feasibility | 33 |
| | Beacon Banks, Husthwaite Lists | 0.6 | 1 – Proposed for design and feasibility | 48 |
| | Beacon Banks, Husthwaite Lists | 0.6 | 1 – Proposed for design and feasibility | 48 |
| | **Howardian Hills AONB Total** | **7.7** | | |
| Lincolnshire Wolds AONB | Hatcliffe – Waithe Beck | 0.8 | 5 – Complete | 48 |
| | Market Rasen, Stainton Le Vale | 0.6 | 5 – Complete | |
| | Hainton | 4.7 | 5 – Complete | 162 |
| | Donington on Bain Mill to Welsdale Bottom | 2.7 | 3 – Confirmed by stakeholder & ready to deliver | 288 |
| | Louth, North Elkington | 4.4 | 2 – Proposed and awaiting land consents | 204 |
| | Louth, Withcall | 2.4 | 2 – Proposed and awaiting land consents | 153 |
| | Stenigot Mast | 2.6 | 2 – Proposed and awaiting land consents | 228 |
| | Withcall to Pokes Hole | 3.2 | 2 – Proposed and awaiting land consents | 288 |
| | Market Rasen, Claxby Village | 5.2 | 2 – Proposed and awaiting land consents | |
| | **Lincolnshire Wolds AONB Total** | **26.7** | | |
| Nidderdale AONB | Grewelthorpe – Masham | 3.4 | 2 – Proposed and awaiting land consents | 540 |
| | Grewelthorpe – Masham | 1.5 | 2 – Proposed and awaiting land consents | 540 |
| | Fountains Abbey – Various Sites | 5.9 | 2 – Proposed and awaiting land consents | 375 |
| | Brimham Rocks | 1.5 | 2 – Proposed and awaiting land consents | 195 |
| | Studley Roger West | 0.6 | 2 – Proposed and awaiting land consents | |
| | Studley Cafe and Pheasantry SSs | 1.0 | 2 – Proposed and awaiting land consents | |
| | Studley Royal | 0.7 | 2 – Proposed and awaiting land consents | |
| | Ramsgill | 0.6 | 2 – Proposed and awaiting land consents | |
| | Timble | 1.1 | 2 – Proposed and awaiting land consents | 252 |
| | Weston, Eastwood Cottages | 1.7 | 2 – Proposed and awaiting land consents | 10 |
| | **Nidderdale Total** | **18.0** | | |
| North York Moors NP | Hinderwell West | 0.2 | 5 – Complete | |
| | Rosedale Chapel | 0.1 | 5 – Complete | |
| | Ayton Garth | 0.6 | 5 – Complete | 209 |
| | Over Silton | 0.6 | 5 – Complete | 144 |
| | Farndale Lowna | 0.3 | 5 – Complete | 280 |
| | Wass | 0.2 | 5 – Complete | |
| | Pockley | 0.9 | 5 – Complete | 108 |
| | Ellerby 1 | 0.4 | 5 – Complete | 108 |
| | Ellerby 2 | 0.2 | 5 – Complete | 108 |

* Stakeholders assess the impacts and benefits of a scheme using a consistent methodology which gives some consideration to the characteristics of the site and of the overhead line, as well as to the visual and environmental impact of the latter. The resulting scores are reported here as an indication of the prioritisation that the scheme is likely to be given relative to others in the same Designated Area. A higher score suggests the site has been given a higher prioritisation by our stakeholders.

**Table 1: continued**

| Designated Area | Location | Length of line for undergrounding (km) | Stage in the process | Stakeholder Rating* |
|---|---|---|---|---|
| North York Moors NP | Mickleby | 1.4 | 5 – Complete | 77 |
| | Danby Castle | 0.3 | 5 – Complete | 306 |
| | Newholme | 0.9 | 5 – Complete | 420 |
| | Newholme North SS | 0.3 | 5 – Complete | |
| | Hawsker York | 0.3 | 5 – Complete | 120 |
| | Silpho | 0.8 | 5 – Complete | 126 |
| | Ainthorpe Davidson & Ainthorpe Brook | 0.7 | 5 – Complete | 110 |
| | Ayton Yedmandale | 0.4 | 5 – Complete | 209 |
| | Egton Bridge West | 0.8 | 5 – Complete | 168 |
| | Staithes Bank Top SS | 0.5 | 5 – Complete | 272 |
| | Ainthorpe East | 0.4 | 5 – Complete | 110 |
| | Cowesby | 0.6 | 5 – Complete | 100 |
| | Low Dalby Beck | 2.1 | 5 – Complete | 224 |
| | Fylingdale Sw – Hawsker Sea View | 3.4 | 4 – Construction in progress | 391 |
| | Dunsley Village | 0.4 | 4 – Construction in progress | 420 |
| | Danby | 1.6 | 3 – Confirmed by stakeholder & ready to deliver | 110 |
| | Whitby, Kildale Percy | 0.3 | 3 – Confirmed by stakeholder & ready to deliver | |
| | Hawsker and Hawsker West | 1.9 | 2 – Proposed and awaiting land consents | 99 |
| | Port Mulgrave | 2.7 | 2 – Proposed and awaiting land consents | 238 |
| | Hawsker Summerfield | 0.3 | 2 – Proposed and awaiting land consents | 100 |
| | Hambleton House | 0.6 | 2 – Proposed and awaiting land consents | |
| | Thornton Dale Westgate SS | 1.9 | 1 – Proposed for design and feasibility | 160 |
| | Low Mill South | 1.0 | 1 – Proposed for design and feasibility | |
| | Thornton Dale | 0.8 | 1 – Proposed for design and feasibility | 160 |
| | **North York Moors NP Total** | **27.7** | | |
| North Pennines AONB | Westgate West SS, Bishop Auckland | 0.5 | 5 – Complete | |
| | St Johns Chapel | 0.9 | 5 – Complete | |
| | Newbiggin Teesdale | 0.4 | 5 – Complete | |
| | County Durham, Rookhope Village | 3.5 | 5 – Complete | |
| | County Durham, Rookhope Village | 0.6 | 5 – Complete | |
| | Eastgate | 1.3 | 3 – Confirmed by stakeholder & ready to deliver | 156 |
| | Co.Durham, Yellocksike | 0.6 | 3 – Confirmed by stakeholder & ready to deliver | 130 |
| | Hexham, Allendale | 3.4 | 2 – Proposed and awaiting land consents | |
| | Co.Durham, Ireshopeburn | 2.8 | 2 – Proposed and awaiting land consents | 168 |
| | Rookhope Head | 3.8 | 1 – Proposed for design and feasibility | |
| | Allenheads South | 3.1 | 1 – Proposed for design and feasibility | |
| | **North Pennines AONB Total** | **20.6** | | |
| Northumberland Coast AONB | Rookhope Head | 3.8 | 1 – Proposed for design and feasibility | |
| | Allenheads South | 3.1 | 1 – Proposed for design and feasibility | |
| | **North Pennines AONB Total** | **20.6** | | |



**Table 1: continued**

| Designated Area | Location | Length of line for undergrounding (km) | Stage in the process | Stakeholder Rating* |
|---|---|---|---|---|
| Northumberland NP | Ingram Village | 1.3 | 5 – Complete | 99 |
| | Rochester SS | 1.9 | 3 – Confirmed by stakeholder & ready to deliver | 220 |
| | Greenwood | 0.7 | 3 – Confirmed by stakeholder & ready to deliver | 171 |
| | Tower Tie – Greencarts | 1.4 | 3 – Confirmed by stakeholder & ready to deliver | 136 |
| | Shield Vallum – Milestone House | 0.5 | 3 – Confirmed by stakeholder & ready to deliver | 207 |
| | Barden Mill, Hexham | 1.3 | 2 – Proposed and awaiting land consents | |
| | Hareshaw Head – Hareshaw Cottages Td | 3.3 | 2 – Proposed and awaiting land consents | 216 |
| | Beggar Bog – Moss Kennels | 0.8 | 2 – Proposed and awaiting land consents | 176 |
| | Carvoran Sw – Thirlwell Castle Sw | 1.8 | 2 – Proposed and awaiting land consents | 253 |
| | **Northumberland NP Total** | **13.0** | | |
| Peak District NP | Moscar | 1.9 | 4 – Construction in progress | |
| | Sheffield, Bolsterstone, Heads Lane | 0.7 | 3 – Confirmed by stakeholder & ready to deliver | |
| | Sheffield, Dunford Bridge | 1.8 | 2 – Proposed and awaiting land consents | |
| | Sheffield, Redmires Road | 2.0 | 1 – Proposed for design and feasibility | |
| | Sheffield, Dunford Bridge, Harden Edge | 2.3 | 1 – Proposed for design and feasibility | |
| | **Peak District NP Total** | **8.7** | | |
| Yorkshire Dales NP | Marrick | 4.0 | 5 – Complete | 216 |
| | Keld | 2.9 | 3 – Confirmed by stakeholder & ready to deliver | 252 |
| | Thoralby West SS | 0.9 | 2 – Proposed and awaiting land consents | 162 |
| | Reeth North | 1.1 | 2 – Proposed and awaiting land consents | |
| | Gayle West End | 0.6 | 1 – Proposed for design and feasibility | 160 |
| | Gayle and Gayle Blackburn | 0.5 | 1 – Proposed for design and feasibility | 160 |
| | Oughtershaw – Cam Houses | 4.7 | 3 – Confirmed by stakeholder & ready to deliver | 390 |
| | Grassington | 2.7 | 2 – Proposed and awaiting land consents | 260 |
| | Kilnsey Crag | 4.3 | 2 – Proposed and awaiting land consents | 260 |
| | Barden Towers | 1.0 | 2 – Proposed and awaiting land consents | 250 |
| | Skipton, Dribbles Bridge House | 2.3 | 1 – Proposed for design and feasibility | |
| | **Yorkshire Dales NP Total** | **25.0** | | |
| | **Grand Total** | **149.0** | | |

**9 stakeholders**

National Park Authorities and Areas of Outstanding Natural Beauty stakeholders consulted.

**101 schemes**

Undergrounding schemes being evaluated in National Parks and AONBs.

## 2.3 Prevention and remediation of oil leakage

### Our target

We are significantly ahead of our business plan commitment to reduce oil/fluid lost to ground by 15% by the end of ED1. We now forecast that oil/fluid loss will be reduced by 47% by 2023 due to our investment in new technologies such as perfluorocarbon (PFT) leak detection[4] and self-healing cable additives.

### Our strategy for reducing and mitigating the environmental impact

Our management of fluid-filled cables compares well with other electricity DNOs in the country, although our exposure is still high because we have more route length of fluid-filled cable in service than most other DNOs. We're addressing this through our fluid-filled cable replacement programme. This year, we replaced 28.2km of fluid-filled cables, taking our total to 68.1km replaced in this regulatory period so far. This puts us slightly behind our target (by 7.5%), but we have identified additional investment we want to make such that by 2023 we expect to have replaced 205.7km of fluid-filled cable which is over 50% more than our original ED1 commitment.

We have been continually developing and refining the innovation project research into self-healing fluid additives, and we are now close to its final formula. The additive is being trialled on sections of cable samples in a laboratory. Subject to the results of these trials, field trials will be carried out on selected out of commission cables in 2019.

- All major GB electricity utilities have fluid-filled cable circuits on their distribution networks. These are mostly of the low pressure fluid-filled type, typically designed to operate at 1–4 bar pressure with short-term peaking pressures up to 6 bar. Over time these cables may begin to leak cable fluid and subsequently the cable pressure may drop and the cable insulation system (fluid impregnated paper or paper-polypropylene laminate) may eventually fail. In some cases the leaks may cause environmental contamination that is of concern to the network operator, and to the public.
- This innovation research and development seeks to exploit the use of naturally occurring, environmentally friendly resins which, when added in measured quantities to the fluid in our cables, have a congealing effect around a variety of sheath defects and minor leaks, that seals the cable and prevents further fluid loss.

### Our performance

If any fluid does leak from our cables then this is considered an environmental incident and we have thorough procedures in place to report these incidents to the Environment Agency and deal with them quickly and effectively to minimise how much is lost.

In 2017-18, we achieved a 44% reduction in oil/fluid lost to ground against our ED1 business plan baseline. We're working to continue to reduce the number of reportable events ahead of our phased plan and we expect the number of these incidents to keep decreasing over the rest of the regulatory period to 2023.

In 2017-18, we set up eight mitigation schemes which include[5]:

- Remedial works at substations to safely remove the water build-up from the inside of the wall that retains any oil leakage and prevents contamination of the surrounding area.
- The installation and replenishing of oil spill kits which act as a temporary 'first aid' solution until the leak can be resolved or the plant replaced. All our field staff working with oil-filled equipment have had spill kit training and they carry spill kits in their vehicles.
- Drainage plans for key sites so that mitigation action can be taken more quickly after an accident such as an oil spill or fire.

Looking forward, we will continue to look for new ways to improve our performance so we can try and outperform our targets. To help us achieve that, we have set a headline environmental goal to reduce the amount of oil/fluid lost in 2018-19 to 30,750 litres. To make this happen, we will:

- continue our progress towards replacing 206.5km of fluid-filled cable network by 2023.
- continue to pre-dose selected fluid-filled cables with perfluorocarbon tracer chemicals to speed up leak locations.
- deploy 'self-heal' additive to fluid-filled cable circuits in a field trial to evaluate the performance of the product.

We have also set ourselves ambitious targets for other key measures including reducing our 2019 target for the amount of Environment Agency reportable incidents from nine to eight.

[4] PFT cost-benefit analysis table is published on: www.northernpowergrid.com/your-powergrid/environment
[5] Further information is provided in Annex 2 (a copy of our annual submission to the regulator).

**Figure 2: Reportable environmental events in calendar year**

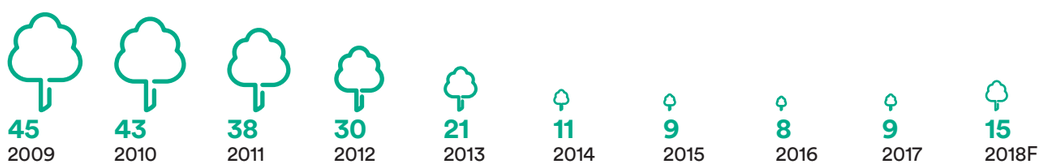
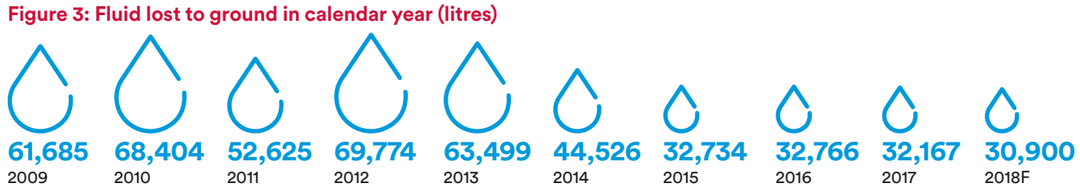



**Figure 3: Fluid lost to ground in calendar year (litres)**






## 2.4 Carbon impact and climate change

### 2.4.1. Business carbon footprint

Our internal carbon footprint continued to fall during the Regulatory Year 2017-18, and so did the carbon footprint of Northern Powergrid combined with our suppliers. If we exclude the contractors' contribution, our internal carbon footprint for 2017-18 was 21,273 tonnes, which is 8.6% lower than the previous year. We report our business carbon footprint in accordance with the Greenhouse Gas Protocol as shown in Table 2[6].

In previous years, we have invested in installing telematics systems in fleet vehicles[7]. We believe that this explains the reduction in fleet fuel use by almost 67,000 litres, as well as a reduction in vehicle accidents. We are now also planning to introduce electric vehicles into our fleet and have adopted a strategy of using battery powered mobile generators (where possible) as opposed to diesel fuelled generators, which is helping us deliver our reliability and customer service targets whilst minimising environmental impact.

We have been running environment awareness training for our staff and refurbishing some depots (taking the opportunity to install low energy lighting with motion sensor activation).

All these actions mean we're firmly on track to achieve our commitment to reduce our carbon footprint by 10% by 2023. Carbon reduction achieved by the end of the Regulatory Year 2017-18 has taken our overall reduction against our ED1 business plan baseline to 34%.

### 2.4.2. Monitoring and reducing the emissions from sulphur hexafluoride

Sulphur hexafluoride ($SF_6$) is an excellent electrical insulator which is widely used in high voltage equipment. However, it is also a potent greenhouse gas – one tonne of $SF_6$ gas is equivalent to 22,800 tonnes of $CO_2$. There is currently no economically viable substitute to $SF_6$ so we have no option but to continue to use it until a suitable alternative is developed by the equipment manufacturers.

The nature of $SF_6$ means it's important to keep the amount that leaks out of our equipment to an absolute minimum. We monitor all $SF_6$ losses on a daily basis by measuring how much we have injected back into the equipment to replace gas which has leaked into the atmosphere. We report our $SF_6$ gas losses as one of our environmental key performance indicators. We estimate that annually 0.28% of the total $SF_6$ volume escapes into the atmosphere (refer to Table 3[8]).

If we discover, either by a remote pressure alarm or on-site inspection, that some gas has leaked, then we schedule maintenance and repair work. If the leak is persistent and maintenance and repair options aren't stopping it, we invest in replacing the equipment.

As we install more $SF_6$ gas equipment and the total volume of gas increases, we have to work even harder to contain the gas within the equipment. To help us with this challenge, we have recently invested £70,000 in a state-of-the-art infrared camera which is able to detect very small quantities of $SF_6$ gas leaking from equipment. We have already used the camera to successfully pinpoint several troublesome leaks which were previously invisible and this has enabled us to maintain and repair the affected equipment. The camera will play an important role in helping to reduce our $SF_6$ gas losses and its initial success has given us the confidence to reduce our 2018-19 target by a further 10% to 100kg and to continue targeting lower emissions each year thereafter.

**Table 3: Summary of performance in $SF_6$ leakage**

| | |
|---|---|
| $SF_6$ bank (kg) | 35,275 |
| Estimate of $SF_6$ emitted (kg) | 98 |
| $SF_6$ emitted as a percentage of $SF_6$ bank (%) | 0.28% |

**Table 2: Our carbon footprint 2017-18**

| Greenhouse Gas Protocol classification | Emissions sources | Tonnes $CO_2e$[9] |
|---|---|---|
| Scope 1 – sources owned or controlled by the company | Gas used for heating buildings | 120 |
| | Operational travel (own fleet vehicles) | 4,976 |
| | Leakage of $SF_6$ | 2,236 |
| Scope 2 – from the generation of purchased electricity, heat and steam | Electricity used in buildings | 2,590 |
| | Electricity used in substations | 7,480 |
| | Losses from our network | 751,356 |
| Scope 3 – all others sources | Network losses from purchased electricity | 942 |
| | Business travel (car, rail, air) | 2,929 |
| | Operational travel (contractors' fleet vehicles) | 11,024 |
| | Fuel combustion (contractors' use of small generators) | 7,238 |
| **Total** | | **790,891** |
| **Total (excluding losses from our network)** | | **39,535** |
| **Total (excluding losses from our network and contractors)** | | **21,273** |

[6] For more information about our carbon footprint, refer to Annex 3 (a copy of our annual submission to the regulator).
[7] Telematics cost-benefit analysis table is published on: www.northernpowergrid.com/your-powergrid/environment
[8] For more information, see Annex 2 (a copy of our annual submission to the regulator).
[9] Tonnes of carbon dioxide equivalent.

## 2.4.3 Distribution losses

### What distribution losses are

While transporting electricity, the transmission and distribution networks incur losses which amount to about 6% of electricity entering the network. These losses are accounted for in the energy consumer's bill and carbon footprint. That is why reducing losses on distribution networks can have a significant effect on overall $CO_2$ emissions for the country.

There are several types of distribution losses:

- **Electrical energy losses** – the natural effect of wires heating up while conducting electricity. These losses vary in proportion to the load transported and are an unavoidable consequence of the laws of physics.
- **Electricity consumed by network operations** – some equipment, tools and functions in our substations need a power supply to work. This is provided by the electricity transported. This is for instance the command and control equipment, and general substation facilities on site (transformer cooling fans and pumps, heating and lighting, and voltage control relays).
- **Electricity theft** – activity conducted by people who access an electricity supply illegally.
- **Inaccuracies in metered and unmetered data** – our routine meter registration processes seek to prevent and remedy any misallocated data flows to ensure that electricity use is linked to customers and their energy suppliers.

### Our strategy to manage distribution losses

We estimate that losses on our network amounted this year to 2,137GWh, equivalent to 751,356 $tCO_2e$. We have a losses strategy in place, dedicated to monitoring and reviewing our options to reduce electrical energy losses that occur on our own network[10]. Our forecast is that losses will reduce by up to 9% between 2015 and 2023 thanks to the effect of the general energy efficiency improvements of our customers' equipment, network density, transformer and cable choice and smart meters. It is important to note that the deployment of smart grids presents a more complex picture as some solutions assist loss reduction objectives, but others increase network losses but deliver whole system carbon reduction through the connection of low carbon generation. The investment profile associated with activities to reduce losses falls into two categories: ongoing programmes and one-off improvements.

**Figure 4: The inside of a LV 300mm² cable used to reduce losses on our network**

[10] The strategy is available in full on our website document library at www.northernpowergrid.com/document-library/

The ongoing activities that we are implementing are:

- **The policy of 'oversizing' conductors (relative to existing utilisation levels):** We install a minimum cable size of 300mm² at 11kV where practical (e.g. if bending radii and termination arrangements allow) and continue to install a minimum of 300mm² mains low voltage (LV) cables that are of a larger capacity than the minimum size option, having taken into account capitalised electrical losses in the assessment of lifetime cost within our designs (Figure 4). Using larger cables to deliver electricity will help us save up to 10,500MWh, enough to power 700 homes for a year. Over the last two years, we have invested in larger electricity cables in order to reduce energy losses, and in 2017-18, this led to a saving of 2,477MWh (refer to Table 4).
- **Sizing the transformer for losses:** We will continue with our current distribution transformer 'oversizing' policy for pole- and ground-mounted transformers with demand customers connected. However, for distribution transformers with dedicated solar or wind generation connected we do not oversize the transformer, as the intermittent generation profiles do not justify the cost for an increased transformer size.
- **Procuring transformers with new loss specification:** We will continue with our current policy to purchase transformers that have lower electrical losses than the minimum cost units available based on having taken into account capitalised electrical losses in the assessment of lifetime cost rather than simply purchase price.

### Losses Discretionary Rewards

Ofgem introduced the Losses Discretionary Reward (LDR) with an aim to encourage all DNOs to undertake additional actions to better understand and manage electricity losses on their networks on four criteria: understanding of losses, stakeholder engagement, processes to manage losses, and innovative approaches to losses management.

The reward was divided into three tranches between 2016 and 2021. We made our tranche 2 submission in February 2018, along with five other DNOs. Ofgem decided not to reward any of the DNOs in the tranche 2 submission as it considered that sufficient evidence was not provided for each criterion to justify giving the DNOs award. We remain committed to delivering the actions described in our tranche 2 submission. Going forward, we are placing emphasis on working with other DNOs on collaborative activity and with academic partners on holistic approaches to managing losses.

### Our performance

In 2017-18, we have been delivering actions spanning both our losses strategy and LDR. In addition to the activities already mentioned, we have commenced the following activity:

- **Enhanced understanding of network losses:** We are working with Newcastle University on a project to build a losses forecasting reference network model. This project will run until 2020 with an aim to better understand and quantify losses so that we can better manage them.
- **Losses on the customer side of the meter:** We commissioned the consultancy WSP to undertake a study investigating the impact of voltage and harmonic variations on domestic customer losses, which includes how the DNO's actions have an effect on the losses on the customers' internal wiring and their appliances, the impact of low carbon technologies on customers' supplies as well as the impact of customers' actions and behaviours towards losses on their side.
- **Transformer waste heat recovery:** In parallel to our decarbonisation effort, we worked with Arup to look into the roll-out of this technology into business as usual. This report discussed the economic and technical feasibility of these solutions and the opportunities on Northern Powergrid's network.
- **Amorphous transformer trials:** We are collaborating with other DNOs and a transformer manufacturer to trial the super low-loss amorphous core transformers on the Northern Powergrid network using standard working procedures. This should help to allay technical concerns around brittleness, size, weight, harmonics and noise in preparation for Ecodesign[11] Tier 2 maximum loss levels for transformers which will come into force in 2021.
- **Stakeholder engagements:** We have organised and have been actively involved in key events and dialogues to engage with the stakeholders and communities to present and discuss our losses initiatives. We have produced an animation to help education customers on what network losses are and how they can be reduced. We also have a dedicated webpage on losses **https://www.northernpowergrid.com/losses**
- **Use of smart metering data:** The University of Sheffield delivered a project on Smart Data on behalf of Northern Powergrid. The primary goals were to determine how a DNO can derive business benefit from smart meter data, whilst providing key recommendations into how this can be done. The key findings in terms of losses were:
  1) Increasing the time resolution of customer demand data can underestimate losses. For example, using 30-minute average demand data (the *de-facto* industry standard) can lead to losses underestimation by 23% compared to one-minute average data.
  2) Aggregating customer demand data can overestimate losses. For example, aggregating six customers' consumption can lead to losses overestimation by 130% compared to no aggregated consumption.
- **LV monitoring:** We've started the roll-out with 60 low voltage monitors (initially) on our heavily loaded and likely losses' hotspots.
- **Network reconfiguration:** Since 2015, over 1,000 high voltage (HV) feeders have been assessed to optimise open points to balance load and customer numbers. In turn, this should reduce losses. In an extreme example when an open point is moved from an interconnected primary substation to the mid-point losses are reduced. For a typical feeder pair to be optimised we estimate around 26MWh/year would be saved or (£1,300/year).
- **Energy Networks Association (ENA) losses taskforce:** As part of the group, we commissioned a study to investigate the impact of low carbon transition on technical losses. This work looked at the losses impact of low carbon technology growth and of the losses impact of smart vs traditional reinforcement. The use of smart solutions as an alternative to conventional reinforcement is expected to increase losses, however Northern Powergrid will only implement smart solutions where they are economic from a whole system perspective.
- **Staff training:** As part of a wider change management exercise driven by Northern Powergrid's Smart Grid Implementation Unit, all high voltage and extra high voltage design engineers (staff and contract) have received formal training in how to incorporate losses into their designs.
- **Accelerated asset replacement:** We undertook a cost-benefit assessment for pro-active replacement of pre BEBs T1:1958 ground-mounted distribution transformers. We are replacing these transformer units as part of synergies with other investment drivers such as asset condition.

Tables 4 and 5 show the volume and impact of loss reduction activity in this first year of the price control period[12].

[11] The Ecodesign regulation is a European legislation that imposes a maximum level of losses for transformers sold from 1st July 2015 onwards. Ecodesign aims for two major objectives on the Transformer product: 1. to reduce electrical losses and 2. to clarify and make more visible indication of performance.

[12] More information, including the Cost Benefit Analysis, is provided in Annex 4 (a copy of our annual submission to the regulator).

**Table 4: Summary of losses costs and benefits from activities in RIIO-ED1**

| | Programme title | Regulatory Reporting Year 2017-18 | | | RIIO-ED1 (2015 to 2023) |
|---|---|---|---|---|---|
| | | Distribution losses justified cost (investment) | Estimated reduced losses due to 2017-18 investment | Reduced emissions associated with losses | Cumulative estimated reduced losses to date |
| | | £m | MWh | $tCO_2e$ | MWh |
| Yorkshire | 'Oversizing' cables (300mm) HV | 0.2 | 179 | 63 | 689 |
| | 'Oversizing' cables (300mm) LV | 0.3 | 369 | 130 | 1075 |
| North East | 'Oversizing' cables (300mm²) HV | 0.0 | 35 | 12 | 200 |
| | 'Oversizing' cables (300mm²) LV | 0.1 | 127 | 45 | 513 |
| **Total** | | **0.6** | **711** | **250** | **2,477** |

**Table 5: Summary of amount of losses activities in regulatory reporting year and estimate for the following year[13]**

| Programme title | Description of unit | Volumes in 2017-18 | Forecast volumes in 2018-19 |
|---|---|---|---|
| 'Oversizing' cables (300mm) HV | Length (Kilometres) | 93 | 45 |
| 'Oversizing' cables (300mm) LV | Length (Kilometres) | 141 | 45 |

[13] We have here reported the activities where some of the costs incurred relate to managing distribution losses, but where losses are not the principal reason for the expenditure. This excludes activities that may help to manage losses but where distribution losses are not associated with the DNO's decision to undertake the activity and where any benefits of losses are purely coincidental (such as the product specification for new transformers, and the programme of voltage reduction which we report in Innovative Solutions). For an overview of all of our activities to reduce losses, refer to our Losses Strategy located at www.northernpowergrid.com/document-library/



## 2.4.4 Climate change adaptation

The UK's climate is changing and weather events which we currently consider to be 'extreme' will become the norm. The climate change that will occur in the medium term has already largely been determined by greenhouse gas emissions so we need to get ourselves ready to deal with the effect this will have on our weather patterns.
In 2017-18, our region suffered one declared major incident (three in 2016-17). A period of nine days of cold weather, accompanied by frequent snow showers moving in from the North Sea, known as the *Beast from the East*, which ended with a period of heavy snow moving north from the near continent, known as *Storm Emma,* caused power cuts to our customers.

From flood defences and vegetation management, to improved weather prediction systems and increased staff availability, we've developed a climate change adaptation strategy[14] that outlines the impact that we anticipate climate change will have on our business and, most importantly, how we propose to tackle it.

We have committed to making our network more resilient to flooding by investing £40m in improving flood defences by 2023 and building 141 new permanent flood defences in that time, as well as completing 15 sites that remained from the previous price control period.

After a slow start to the RIIO-ED1 period, we are now ahead of schedule after we upgraded the defences at 64 sites this year; more than double our target for the year (refer to Table 6).

**Table 6: Annual number of permanent flood defences installed**

| 2017-18 Actual | 2018-19 Target | 2015-23 Cumulative | 2015-23 Target |
|---|---|---|---|
| 64 | 31 | 119 | 141 |

Since making our business plan commitment, there have been a number of severe flooding events that triggered a national review of flood resilience as well as causing us to carry out our own analysis. The result is that we have expanded our programme to target improvements at an additional 98 sites, 45 sites that were identified as part of the national flood resilience report and 53 new sites from our own flood analysis. This takes the total number of sites targeted for improvement during the RIIO-ED1 period to 254.

We remain on track to complete our original RIIO-ED1 commitment of 141 sites during the next year and complete the entire programme of 254 by 2023.

Following the release of The UK Climate Projections 2018 later this year, we are planning to participate in the ENA Climate Change Adaptation working group to understand the impact of these predictions on our networks. We will work to create a co-ordinated industry response to the predictions and we will seek to review our Northern Powergrid Climate Change Adaptation Report and strategy in line with the timescales laid out in the National Adaptation Plan.

[14] Available from: northernpowergrid.com/asset/0/document/2032.pdf

## 2.4.5 Increasing our recycling efforts

We are committed to making a difference for the environment. In 2017-18, we have made further efforts in reducing the amount of plastic we use as well as recycling the used plastic.

After reviewing our purchases, we identified an opportunity to reduce the number of plastic cups we use. In March, we successfully trialled this approach by removing the plastic cups from one of our sites. Now, plastic drinking cups have been gradually withdrawn from water machines throughout the rest of our offices. From now on, plastic cups will only be available in selected sites, recognising the needs of external visitors.

In addition to that, we have partnered with our contractors to recycle the plastic buckets that contain resin used for jointing. In July, we took our first load of empty plastic buckets to a local plastic recycling facility. There, plastic is shredded into pellets for producing new goods, such as plastic pipes, waste bins, flower pots, and dashboards for cars.


# 3. Smart grids, innovation and our role in the low carbon transition

## 3.1. Introduction

### Developing our innovation portfolio

As a company, we aim to improve our customers' experience through new understanding and processes across all parts of our business – both today and in the future. This year, we've made more progress on our mission to modernise and in rolling out innovation projects into our everyday business. We currently have 26 active innovation projects, building on work that's already been done in the industry, to help us deliver our innovation strategy.

### Changing markets and system operation

We are going through a revolution in the way that electricity is produced and consumed. Traditionally, the distribution network was designed for one-way delivery of electricity. Over the last few years, customers and the energy industry have made some big changes:

- **Decarbonisation of generation:** Less coal and more wind and solar are being used to power our homes.
- **Decentralisation of energy sources:** Electricity generation units are moving from the traditional model of large power stations on the transmission network to commercial and domestic generation connected to the local distribution powergrid.
- **Digitisation of technologies:** Most things are becoming 'smarter' in society (e.g. home entertainment and heating controls) and in industry (e.g. technology to automate processes and control network assets).

Traditionally, electricity generation has been adjusted to meet demand (or use). However, low carbon generation is less flexible because the source is often weather dependent (for example, solar panels and wind farms) and is more intermittent. This means that the system needs to be more flexible to support customers by matching demand to available generation and have the ability to cope with a more dynamic two-way flow of power on the network.

The industry is responding to this change by transitioning from a traditional DNO to a Distribution System Operator (DSO) model. DSO requires active management of the network in real time, agreeing contracts with customers to support the grid in flattening peaks of high demand on the system. Operating as a DSO means we will work with customers who are able to be flexible with when they generate or use electricity. In doing so we aim to support more low carbon generation, reduce system costs and improve overall energy system efficiency for all customers.

### Smart meter foundations

Although energy suppliers are leading the roll-out of smart meters, network companies have an important role to play supporting the roll-out and using smart meters as the foundation of a future smart grid which will deliver an improved service for our customers. We've achieved our industry milestones this year and started modifying our business processes to deliver the most benefits for our customers. You can read more about this in section 3.4.

### Drivers and priorities

Our commitment to operational excellence and customer service means that we are always looking for better ways to do things, at a reduced cost for our customers. Our role is to provide the electrical infrastructure for the future and as the UK energy landscape changes to meet carbon reduction targets, new demand for renewable electricity, electric vehicles and heat pumps is placed on our network. We need to manage the network so it continues to provide a secure supply of electricity. Developing trends present both challenges and opportunities for the electricity system and we keep it under review to make sure our approaches and priorities remain appropriate. Changes are driven by technological advances and the need to reduce carbon:

- **Customer engagement** – our priorities need to be linked to those of our customers.
- **Security of supply and cost remain a top priority.**
- **Local and intermittent generation** – driven by incentives for renewables and placing new demands on the system.
- **Decarbonisation of heat and transport** – a heat pump or an electric vehicle charger can double the peak load on a domestic property with most impact when clustered in the same location on the network.
- **Digitisation** – the pace of technological change is leading to a rapid increase of data and functionality to engage customers in an actively managed network.

**About a Distribution System Operator**

By making the transition to a DSO, Northern Powergrid will deliver a set of balanced outcomes for customers through:

- creating a customer-led actively managed (and probably semi-autonomous) network.
- providing a cost-efficient, non-discriminatory and technology-neutral physical trading platform.
- supporting third parties in our region to participate in the electricity markets.

At Northern Powergrid, we want to be a leading voice in shaping the transition. Many of the projects we've worked on this year support this ambition – we're involved in activities that are scoping the future, pursuing low-regrets options (getting on with the transition) and building new capabilities.



**Table 7: Low carbon technologies connected to our network in 2017-18**

| | | Estimated capacity (MW) | Estimated volume |
|---|---|---|---|
| Load | Heat pumps | 4 | 877 |
| | Electric vehicle chargers | 7 | 1,127 |
| Renewable generation | Photovoltaic micro-generation | 7 | 1,730 |
| | Other distributed generation (mainly larger photovoltaic, onshore wind and biomass) | 372 | 94 |

### Our role in the low carbon transition

Carbon reduction targets have led to an increase in popularity for low carbon technologies (LCT) such as heat pumps, solar panels, wind turbines, and electric vehicles, with low carbon heat remaining an uncertainty. This places increased and new demand on our network. Table 7 shows the amount of such connections on our network[15].

In terms of future volumes, the rate of LCTs uptake is very sensitive to government policy and the market's ability to find profitable business models. During 2015-16, for example, feed-in tariffs and renewable heat incentives were reduced and the renewables obligation closed for new onshore wind operators. In 2017, the plans to ban new petrol and diesel car sales from 2040 were announced. As a result, the uptake of LCTs has been slow and we've seen a continued decrease in micro-generation photovoltaic connecting to our network, but the uptake of electric vehicle chargers has slightly increased. We expect to see a stable trend of distributed generation in the short term – perhaps as long as a year – before it picks up as markets identify new business models.

These challenges are set against a backdrop of disruption to traditional energy markets where new entrants are blurring the established definitions of generators, suppliers, network companies, customers and other market participants. Added to this, customers expect that service standards and security of supply will continue to improve.

In our innovation strategy, we have set out four key priority areas where we are changing our services to provide benefits for our customers:

- Deploy smart grids
- Maximise the value of smart meters
- Develop digital-enabled services
- Address affordability.

We are involved in innovation in various ways: either by leading projects or by working with partners. Projects are funded through different sources. We have access to the Network Innovation Allowance (NIA) through the regulator Ofgem, which is worth up to £29m over eight years, and we can also benefit from specialist funding sources (such as Innovate UK) through partnering with universities or other industrial partners.

In 2017-18, we successfully launched 11 new projects to help us address issues of affordability, environment protection and the deployment of smart grids[16].

## 3.2. Progress made on our innovation strategy

Our innovation strategy has been used to discuss our priorities with our stakeholders over the past year – most notably our stakeholder panel and the connections customer forum. The four key priority areas set out above continue to be relevant. We have actively contributed to developing the ENA Electricity Network Innovation Strategy this year, and we will use it to modify our own innovation strategy.

**We have made good progress on our four strategic innovation priorities:**

**Smart grid development** is largely focused on introducing flexibility so that the network can accommodate more intermittent renewable energy. In 2017-18, we:

- are running the large Customer-Led Network Revolution (CLNR) battery for commercial operation.
- started our Customer Led Distribution System[17] innovation project which is helping to gather evidence on future customer behaviours to inform the most appropriate market design and industry structure for the future energy system.
- continue to explore new ways to optimise the whole energy system (electricity/gas) as well as the relationship between electric vehicles and the electricity networks.
- have started exploring innovative ways to increase resilience to vulnerable parts of the network through application of systems of technologies.
- rolled out new monitoring and protection equipment as part of our £4m project to revolutionise the way we will manage future replacement and repair on our low voltage network, and started to see the first results.

Our work around **smart meters** has remained focused on establishing solid foundations for the exciting new services and benefits that should be made possible by the national programme when data becomes available. In 2017-18 we have:

- continued to maintain the security compliance of our system to access the national system data.
- started to use smart metering data operationally for the benefit of our customers.
- commenced projects to integrate smart metering data with our Network Control and Customer Relationship Management Systems.

You can find out more about this work in the Smart Energy section of this report.

[15] For more information, refer to Annex 7 (a copy of our annual submission to the regulator).
[16] For more information on our portfolio of NIA projects, you can refer to our 2017-18 Annual Summary on: http://www.northernpowergrid.com/asset/0/document/4557.pdf
[17] More information available from http://www.northernpowergrid.com/innovation/projects/customer-led-distribution-system-nia-npg-19

For **digital-enabled services**, we have improved the tools used by our operational and network teams in order to give our customers great customer service. Specifically, we have:

- completed the final testing stages of our 'eAM Spatial' programme created to modernise our asset management system. We are now are in the implementation phase, rolling out training across the organisation.
- developed our innovation project on forecasting customer electricity use, based on roll-out scenarios for electric cars, heat pumps and distributed generation to see the first forecasts useable in the business-as-usual environment.
- started work on a web-enabled system to allow customers to produce the designs for straightforward connections to provide them with faster and more efficient customer services.
- started work on a web-enabled safety system to provide our engineers with spatial and temporal information of approaching thunderstorms, to enable them to protect themselves and our assets.

**Affordability** work has focused on cheaper supply models for electricity customers. In 2017-18, we have:

- completed projects that will reduce oil cable and overhead line pole costs in the longer term.
- trialled a technology to reduce interventions on the low voltage system. This will give us a better view on when and where faults are developing, allowing us to intervene before the faults become permanent and impact our customers.
- commissioned a feasibility study for the provision of re-purposed electric vehicle batteries for vulnerable customers reliant on electrically powered medical equipment to avoid the negative effects of a temporary disconnection.

## 3.3. Roll-out of smart grids and innovation into business as usual

Delivering innovative change is the only way we can continue to serve our customers and deliver the outcomes they value. This means that when we're considering innovation, our focus is as much on delivering change as it is on opening trials. Innovation comes through a variety of routes – from changes to how we run our business every day to collaborating with external parties and delivering projects we have funded through a variety of rates.

### 3.3.1 Innovative solution deployed: Turning innovation into business as usual

Inspired by new ideas promoted by third parties or by other network operators, and basing our decision on cost-benefit assessments, we deploy new solutions as standard practice. In 2017-18, we've deployed (or continued to deploy) six such solutions, and report on them in Table 8[18].

### 3.3.2 Innovation in connections

The connection of renewable energy was one of our main focus areas again this year and we've connected a further 379MW. Our innovation in this area has progressed as set out in Table 8.

In previous years we have reported on a number of other initiatives: Releasing capacity – generation and demand, Telematics in operational vehicles, Fire retardant workwear, LV technology programme, and Farm safety communication campaign. We have removed these projects from the above table this year as they have been rolled out as standard business practice.

#### Voltage reduction

We've continued to roll out our voltage reduction initiative at primary substations at a further 82 sites, creating an extra 738MW of headroom for new micro-generation.

#### Flexible connections

We have 408MW of contracted flexibility in our existing three active network management (ANM) zones. In the Driffield area, we are now bringing forward a solution for customers which, once operational, might be replicated in other parts of our network as necessary. In the Driffield, the majority of site installation works are near completion and the next steps through the remainder of 2018 and into early 2019 are:

- the installation of control equipment at our control centre in Leeds
- factory and site acceptance testing
- whole scheme commissioning with the scheme going live in Q1 2019.

#### Battery storage

In March 2018, our Contracted Capacity Register[19] shows that we had almost 4MW of storage capacity connected to our network, and almost 1GW of accepted capacity, indicating an increasing volume of activity from our customers.

We have facilitated the introduction of this new type of energy asset by providing guidance to our customers, and we've proved our understanding of the battery storage technology impact on our network by providing dynamic frequency response services using our 2.5MW CLNR unit installed in Darlington.

In September 2017, we held a workshop on domestic energy storage. This proved to be so popular that all available spaces were filled within the first few hours of us announcing the event. We re-ran it in November 2017 for customers on our waiting list.

### 3.3.3 Rolling out the smart grid

In order to pre-empt the high levels of growth in low carbon technologies that we expect beyond 2023, we invest in enabling technology such as modern communications and control equipment. This lays the foundations of a smart grid, on which we expect to spend a total of £83m up to 2023. Our dedicated smart grid unit is starting to build the activity levels of our investment programme with activity being split across specification development, procurement of services and actual delivery of new smart grid technology. We have started to replace our transformer control relays at primary substations, run a proof of concept for the next generation substation control unit, procure a higher performance communications network for our primary substations, and install monitoring on low voltage feeders at distribution substations.

[18] For more information on the cost and benefit analysis that guide our investment decisions, see Annex 6 (a copy of our annual submission to the regulator of related information). CBA tables are published on: www.northernpowergrid.com/your-powergrid/environment
For more information on network innovation projects, refer to www.smarternetworks.org/

[19] Available at: http://www.northernpowergrid.com/contracted-capacity-register

**Table 8: Innovative solution deployed**

| Innovative solution deployed (benefiting operational outcome) | Estimated benefits and impact 2017-18, resulting from the deployment | Deployment volumes 2017-18 | Estimated deployment volumes 2018-19 | Relevant innovation trial (when applicable) |
|---|---|---|---|---|
| **Increase Network Capacity, Optimise Utilisation (Connections)** | | | | |
| **Voltage reduction at primary** Lowering the voltage on the HV networks creates headroom for the connection of rooftop solar panels on the LV system which would otherwise cause the voltage to rise above the upper statutory limit for penetrations greater than 30%. | Freed LV generation capacity: 738MVA | Deployed to 82 substations | 120 | Customer-Led Network Revolution, Northern Powergrid and Voltage Reduction Analysis |
| **Improve Connection Performance (Connections)** | | | | |
| **Flexible connection agreements for generators** Generation customers are offered an alternative connection quotation at a lower cost in exchange for occasional constraints on their export. | N/A | No new deployments this year | 4 | N/A |
| **Improve Asset Life Cycle Management** | | | | |
| **Transformer insulating oil online regeneration** Treatment of the oil used as an insulator in a transformer to remove any acidity and moisture which extends its life. | Gross avoided costs: £0.6m | Deployed at 6 substations | 6 | N/A |
| **Improve Network Performance (Reliability and availability)** | | | | |
| **LV technology programme** A proactive approach to LV network intermittent faults by using new technology which will automatically restore intermittent faults and locate faulty kit. | Avoided customer minutes lost: c. 4.5 million<br>Avoided customer interruptions: c. 44,700<br>Gross avoided costs: £0.2m | No new units – continued re-deployment of existing 736 units | Continued re-deployment of the existing units | The Smart Fuse, ENW |
| **Automatic Power Restoration System (APRS)** Identifies the location of faults on the HV network and speeds up resolution. | Avoided customer minutes lost: c. 477,400<br>Avoided customer interruptions: c. 95,500 | Deployed to 35 substations | 40 | N/A |
| **Improve Environmental Impact (Environment)** | | | | |
| **Fluid-filled cable leak detection by perfluorocarbon tracer** Method to locate, with improved precision, a leak in our cables. | Avoided oil leakage: c. 8,250 litres<br>Gross avoided costs: £0.6m | Deployed on 11 circuits | 7 circuits | N/A |

**Smarter powergrid**
A smarter network makes use of real-time information on network performance and energy consumption to respond to and manage demand and maintain a more efficient, affordable and low carbon flow of energy. By doing so, a smarter network will also enable the growth of new customer technologies such as electric vehicles, renewable generation and heat pumps, among others.

**738MVA**
generation headroom created by rolling out innovation solutions in connections.

## 3.4 Getting the most out of smart meters for our customers

The first smart meters were connected to the central meter reading services in Q4 2017. We ensured we had our system in place and our people ready to start delivering a better service to our customers from the first days of these meters being connected, and we achieved that goal[20]. We have been regularly reviewing our processes to ensure we continuously improve as meter numbers increase.

### 3.4.1 Progress towards mass roll-out

The roll-out of 'foundation stage' smart meters has continued and we expect it to pick up pace over the next few years up to five times its current rate. We're continuing to support the roll-out of smart meters, in line with our business plan commitments and our strategy (see Figure 5).

Technical issues with the national smart meter service and a slower roll-out of second generation meters in our licence areas mean that the data, which we'll use to improve our network performance, isn't reliably available yet. This year we've been focusing on making the data available to our operational teams in line with our strategy for using smart meter data.

### 3.4.2 Supporting the roll-out

The roll-out of the smart meters is being led by energy suppliers, but DNOs have an important role in delivering them and setting up the two-way communications with the smart meters through an IT Gateway, to make sure customers get all the possible benefits from the smart meters. We have:

- been actively engaging with energy retailers and their meter operators to provide visibility of our performance and collaborating to ensure efficient resolution of any issues identified on our network that are preventing smart meter installations.
- piloted our online appointment booking tool for suppliers' agents and made enhancements. The meter installer can now arrange for defects to be dealt with directly with our service provider with the customer's agreement, allowing the installer to co-ordinate their return and avoid unnecessary disruption for customers.
- delivered defect repairs at customer premises in line with agreed industry service level agreements.

Safety, planning and innovation underpin our approach to collaborating with energy suppliers and meter operators in order to make sure the UK's smart meter roll-out runs as smoothly as possible in our region.

- Last year, we authorised just over 800 meter operator installers to work safely on our equipment, over 300 of them having been accredited at our own training facilities.
- When meter operatives encounter an issue meaning installation cannot go ahead on the initial visit, we've ensured that we've got the manpower in place to resolve the defect as soon as we can.

**Table 9: Innovative solution deployed**

| | North East | Yorkshire | Northern Powergrid |
|---|---|---|---|
| Smart meters deployed by suppliers in the Regulatory Year 2017-18 | 211,794 | 261,255 | **473,049** |
| Total meters eligible for transition to smart | 1,589,863 | 2,281,093 | **3,870,956** |
| % penetration | 13.3% | 11.5% | **12.2%** |

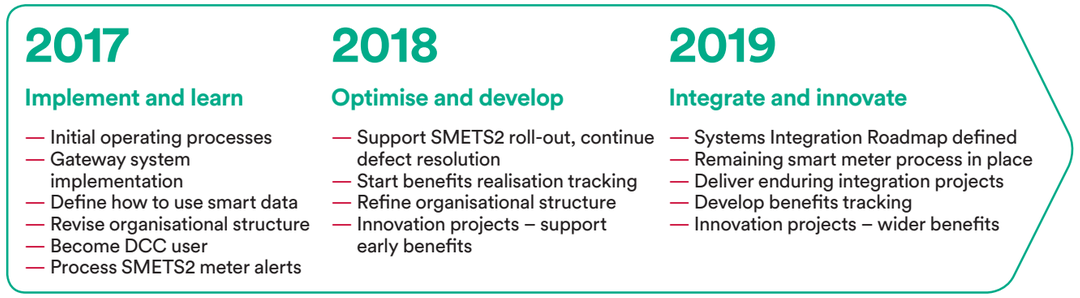
**23,295 smart meter**
defects resolved within target timeframes

**473,000 smart meters**
installed by energy suppliers

[20] For more information on the smart meter roll-out, refer to the government website www.smartenergygb.org



**Figure 5: A summary of our strategic plan to support the smart meter roll-out and maximise its benefits**




### 3.4.3 IT and communications investment

We've been busy making all the necessary changes to systems and business processes. This year we have:

- remained compliant with our security obligations and authorised a series of projects to make sure customers benefit by ensuring our operational teams with the Contact Centre, Dispatch and Control can access important alert data. Table 10 summarises the smart meter IT and data costs that are passed through to our customers that we have incurred this year[21].
- worked with the suppliers who operate in our region to ensure the safety of roll-out activities.
- monitored our business processes and where necessary improved our working practices to deliver the most benefits for customers.

### 3.4.4 Actions we expect to take next year

In 2018-19, we will move from the Optimise & Develop phase to the Integrate & Innovate stage (Figure 5) as we expect meter volumes to increase significantly from the spring of 2019. We will be developing our process and organisational structure to meet the increased amount of work.

Next year we look forward to delivering benefits to our customers as energy suppliers will move to rolling out second generation, SMETS2 specification, meters connected to the DCC. We also look forward to early generation smart meters, SMETS1, being enrolled in the national service. We have started tracking benefits and will begin some innovation projects.

**Table 10: IT and communications costs for 2017-18**

| | £m |
|---|---|
| Smart Meter Communication Licensee Costs (pass through) | 2.31 |
| Smart Meter Information Technology Costs | 1.76 |
| Elective Communication Services | 0.00 |
| Smart Meter Communication Licensee Costs (outside price control) | 0.00 |
| **Total** | **4.07** |

**Notes for Table 10**

- Smart Meter Communication Licensee Costs: the charges paid by the licensee to the holder of the Smart Meter Communication Licence as a requirement for it to be a party to the Smart Energy Code.
- Smart Meter Information Technology Costs: any information technology costs that the licensee reasonably incurs and are necessary for them to use data from smart meters effectively for the efficient and economic operation and maintenance of its Distribution System.
- Elective Communication Services: Payments for discretionary data services purchased through bilateral agreements with the Data Communications Company (DCC). The DCC data services were not live during any part of the 2017-18 Regulatory Year so no non-elective data or Elective Communication Services have been bought from the DCC.

[21] More information is provided in Annex 5 (a copy of our annual submission to the regulator of related information) and in the 'Detailed commentary' document associated with it.

**Table 11: Smart meter benefits actions in 2018-19**

| Actions | Benefits for customers |
|---|---|
| — Upgrade our IT systems to process smart meter data which may help us better understand power used by our low voltage electricity customers and how to measure network losses more accurately. | Avoided losses to network operators. |
| — Upgrade our IT systems to process smart meter data (including automated power cut alerts) and make it available to our operational teams.<br>— Integrate alerts in the redesign of our operational process to allocate staff to power cut repairs. | Reduction in the length of power cuts. |
| — Upgrade our IT systems to process smart meter data (including automated power cut alerts) and make it available to our operational teams.<br>— Integrate alerts in the redesign of our operational process to locate faults. | Reduction in operational costs to fix faults. |
| — Upgrade our IT systems to process smart meter data (including automated power cut alerts) and make it available to our operational teams.<br>— Integrate alerts in our distribution network outage management system. Although levels of inbound calls may drop, outbound contact with our customers will remain high as we proactively update customers about power cuts and the time they can expect their power back on. | Reduction in calls to faults and emergencies lines. |
| — Upgrade our IT systems to process smart meter data (including automated voltage alerts) and make it available to our operational teams.<br>— Integrate the information flowing from the data in the redesign of our network planning processes relating to new connection design, reinforcement design and voltage quality assessment. | Better informed investment decisions for electricity network reinforcement for quality of supply. |
| — Upgrade our IT systems to receive smart meter data (including automated power cut alerts).<br>— Integrate alerts in the redesign of our operational process to allocate staff to power cut repairs.<br>— Integrate the information flowing from the data in the redesign of our network planning processes relating to voltage quality assessment. This is particularly exciting as it is an area where we currently hold very little data, other than when a customer notifies us of a voltage problem. | Avoided cost of investigation of customer complaints about quality of supply. |
| — Progress our request to Ofgem for half-hourly consumption data from smart meters to help us better understand the usage profiles of low voltage electricity customers and explore ways to save money on network improvements. | Network capacity investment savings from electricity demand shift. |

# Contact us regarding our plan

**We believe that our customers and stakeholders are the best judges of our performance. We always want to hear your views and opinions on the services we provide and your ideas for what we could be doing. If you would like to comment, you can contact us in a number of ways:**

## By email
**yourpowergrid@northernpowergrid**

## On twitter

## @northpowergrid
**(for power cut information and advice)**

## @powergridnews
**(for information about the company and the work we do in communities)**

## Online at:
**www.northernpowergrid.com**

## Connections enquiries

## By telephone
**0800 011 3433**

## By email
**getconnected@northernpowergrid.com**

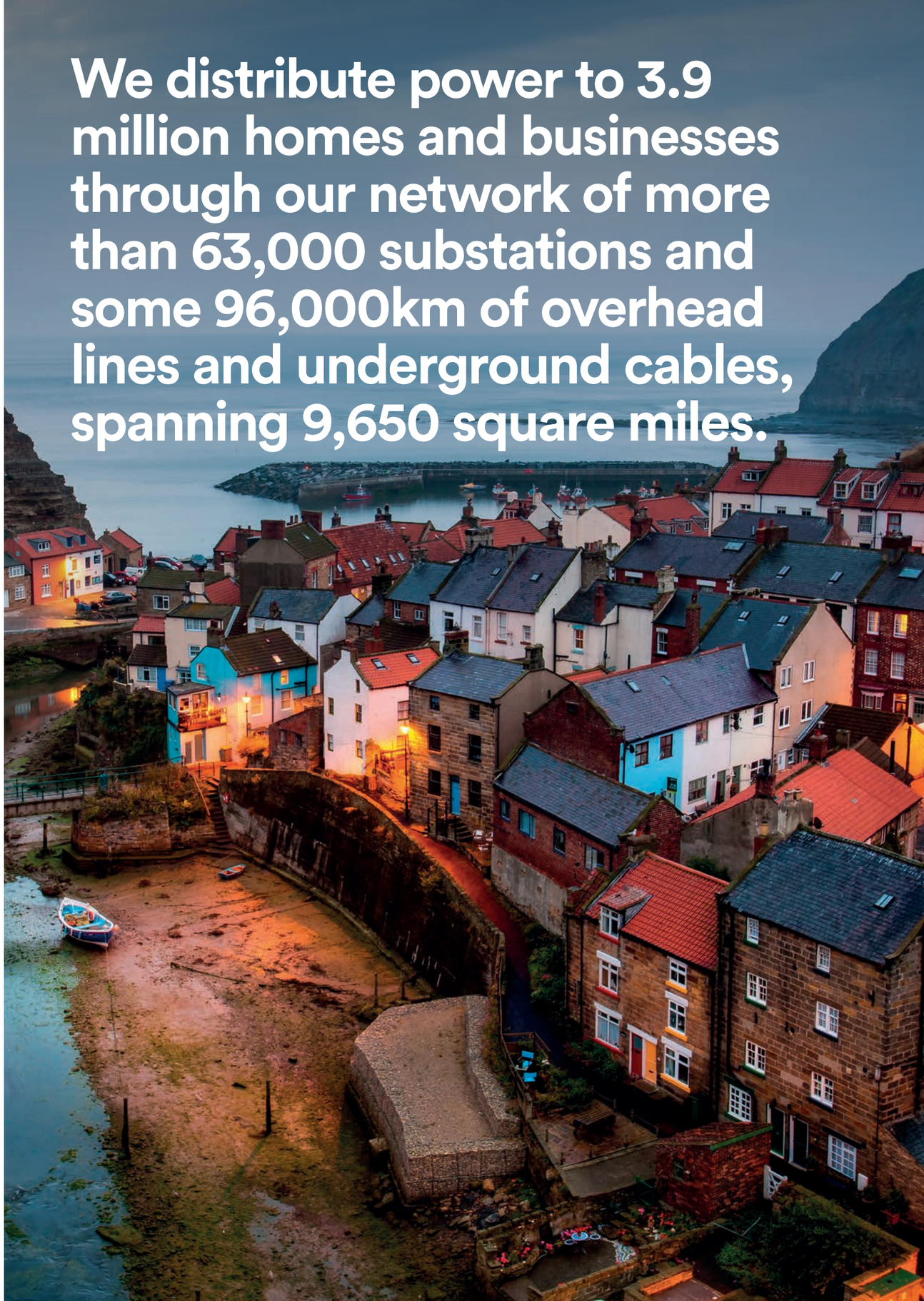
## General enquiries

## By telephone
**0800 011 3332**

## By email
**cus.serv@northernpowergrid.com**

# Notes




We distribute power to 3.9 million homes and businesses through our network of more than 63,000 substations and some 96,000km of overhead lines and underground cables, spanning 9,650 square miles.